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# GREEN VALLEY CAMPGROUND BIOLOGICAL EVALUATION, SAN BERNARDINO NATIONAL FOREST

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## ABSTRACT

An evaluation of the Green Valley Campground on the Arrowhead Ranger District indicated high levels of western dwarf mistletoe on Jeffrey pines. Many overstory and understory pines were moderately to severely infected. Annosus root disease centers, associated with Jeffrey pine and white fir stumps, were found at five locations. Armillaria root rot was found in white fir stumps at three locations. True mistletoe was present on white firs and incense cedars. Insect activity was low. The biologies of the major pests are discussed and management options, including an integration of treatments, are presented. The consequences of each option, including no action, are discussed.

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## INTRODUCTION

The Green Valley Campground was examined on January 27 and 28, 1981, by Dave Schultz (entomologist), John Kliejunas and Jim Allison (pathologists) of the Forest Pest Management Staff. They were accompanied during part of the evaluation by Jim Bridges and Ken Slater.

The objective of the evaluation was to develop alternative pest suppression-prevention methods which could be programed into the vegetative management plan for the campground. Particular interest was expressed in alternatives available for reducing the high levels of mortality due to the dwarf mistletoe present in pine, and determining the factors contributing to the mortality of white firs in some areas of the campground.

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## OBSERVATIONS

Vegetative cover consists of an overstory of predominantly Jeffrey pine with white fir and incense-cedar present in some areas; a few sugar pines are present. Black oaks are present and scattered throughout the campground. The understory consists of white fir, occasional incense-cedar, and a few Jeffrey pine. Willows occur along the low drainages and a ground cover of white thorn is scattered throughout the area. Problems noted in and around the campground follow.

### WESTERN DWARF MISTLETOE

Western dwarf mistletoe, Arceuthobium campylopodum, was extremely common on Jeffrey pines throughout the campground. Because of its widespread occurrence, no attempt was made to map the dwarf mistletoe-infected trees. Many overstory pines had Hawksworth dwarf mistletoe ratings of five or six (severely infected), and numerous brooms were present. The few Jeffrey pines present in the understory were also heavily infected with dwarf mistletoe.

### ANNOSUS ROOT DISEASE

Annosus root disease, caused by Fomes annosus, was found at five locations (see attached campground map). Confirmation was based on the presence of F. annosus conks within stumps or incubation of collected wood samples in the laboratory. Locations of annosus centers are as follows:

A: On the hillside behind sites 19 and 20. Conks were found in one Jeffrey pine stump.

B: Conks were found in one pine stump uphill, and in one pine stump downhill, from the road, between sites 6 and 19.

C: At site 7. Two stumps were infected.

D: South of site 1. Conks were found in one pine stump. A declining overstory Jeffrey pine was adjacent to the stump.

E: Near the walk-in unit (site 34?), below the water tanks. Conks were found in a hollow fir stump.

### ARMILLARIA ROOT ROT

Armillaria root rot, caused by Armillaria mellea, was associated with stumps at three locations:

A: One white fir stump adjacent to the annosus-infected stump behind site 19.

B: One white fir stump in the vicinity of sites 15 and 17.

C: Three white fir stumps on the hillside east and across the road from site 11. A dead white fir was adjacent to one of the infected stumps and oak stumps were present in the vicinity.

In addition, an open area on the hillside behind site 9 was a suspected root disease center. Signs of F. annosus or A. mellea were not found but three oak stumps were present, one overstory white fir tree had a fading crown, and a group of sprout oaks on the margin of the opening were dying.

INSECT PROBLEMS

One dead white fir tree behind the comfort station across the road from site 19 was attacked by the fir engraver, Scolytus ventralis. Fir engraver attacks were also present on four dead white fir trees in the vicinity of sites 15 and 17. Armillaria was not found on these trees, but it was present on a nearby white fir stump.

A dead fir tree just north of the comfort station west of site 9 was attacked by the roundheaded fir borer, Tetropium abietis. Two pine stumps were present under the snow in the vicinity, but F. annosus or A. mellea were not found.

A group of three Jeffrey pine trees in the vicinity of site 26 was attacked by the Jeffrey pine beetle, Dendroctonus jeffreyi. One of the trees is currently infested and is dead. Attacks on the other two trees were not successful.

OTHER PROBLEMS

True mistletoes were present on white firs and incense-cedars. White fir true mistletoe, Phoradendron bolleanum ssp. pauciflorum, was present in one discrete location, on a few trees on the hillside behind site 37. Other white firs throughout the campground were unaffected. Incense-cedar true mistletoe, Phorandendron juniperinum ssp. libocedri, was common on cedars in the vicinity of sites 34 through 38.

A few trees, hazardous because they have been significantly impacted by insect, disease, environmental or mechanical stresses, were observed. At site 30, one incense cedar with only a few remaining roots, and a white fir with excessive lean next to the cedar, were noted. An incense cedar with a thin, off-color crown, probably due to excessive exposure of the roots, was present behind site 33. A Jeffrey pine with some internal decay and moderate lean was present at site 36. A Jeffrey pine at the entrance to the campground had a spike top.

Oxidant air pollution (ozone) damage on Jeffrey pines was light to severe throughout the campground.

## BIOLOGY OF PEST ORGANISMS

### WESTERN DWARF MISTLETOE

Western dwarf mistletoe, Arceuthobium campylopodum, infects Jeffrey, ponderosa, knobcone, and Coulter pines. Other conifers or hardwoods are not infected by this particular species. Dwarf mistletoes are obligate parasites that are completely dependent on their host for support, water, and most of their mineral and organic nutrients. They often cause the formation of "witches' brooms", or dense masses of distorted branches, on the host that divert nutrients from the rest of the tree. Infection can cause growth reduction, abnormalities, mortality and predisposition to attack by other pests. In particular, infected trees appear to be more susceptible to attack by bark beetles and the California flatheaded borer than do uninfected trees. The dwarf mistletoe/bark beetle complex is responsible for 40 to 60% of the pine mortality in southern California during years of normal precipitation. Mortality is more frequent when other stress factors occur, such as drought, poor site, oxidant air pollution damage, or competition in overstocked stands.

Dwarf mistletoe spreads between trees and within crowns of trees by means of small seeds that are forcibly ejected into the air. Spread from overstory to understory is limited to the distance the seeds are shot, generally 20 to 60 feet, but as much as 100 feet if assisted by wind or on steep slopes. Dwarf mistletoe spreads upward in pines at an average rate of 4 inches per year.

### ANNOSUS ROOT DISEASE

Fomes annosus is a fungus that attacks a wide range of woody plants, causing decay of the roots and butt and the death of sapwood and cambium. All conifer species in California are susceptible to the fungus. Hardwood species are rarely damaged or killed. Madrone (Arbutus menziesii), and a few brush species (Arctostaphylos spp. and Artemisia tridentata) are occasional hosts.

During favorable periods, the fungus forms fruiting bodies (conks) in decayed stumps, under the bark of dead trees, or in the duff at the root collar. The fungus becomes established in freshly cut stumps from airborne spores produced by conks, and then grows into the root system. The fungus subsequently spreads to healthy roots of surrounding susceptible species via root contacts. Local spread of the disease outward from an infected stump typically results in the formation of a disease center, with stumps and older dead trees near the center and fading trees on the margin. The centers continue enlarging until they reach barriers, such as openings or groups of non-susceptible plants.

The fungus may remain alive for as long as 50 years as a saprophyte in rotting roots and stumps. Young susceptible trees invading the site often die after their roots contact old infected root systems in the soil.

ARMILLARIA ROOT ROT

Armillaria mellea is a fungus which causes a root and root collar decay of more than 600 species of conifers, hardwoods, shrubs and herbaceous plants. After the fungus has developed in an infected tree, it uses the dead stump or root as a food base to produce structures called rhizomorphs. Rhizomorphs formed on decayed wood grow through the soil and may infect living trees in the vicinity, especially young firs and pines. When the rhizomorph contacts a susceptible root, it adheres and penetrates through the bark to the cambium region. The fungus grows in the cambial area and produces a creamy white, flat leathery, fan-shaped mycelial mat. A network of rhizomorphs is often associated with the mat. From the mats the fungus penetrates xylem tissue and produces a white to yellowish stringy rot that is often accompanied by fine black zone lines.

Armillaria mellea is present in most forest stands and is usually prevalent where oak is a stand component. Since the fungus exists in most soils, successful infection is usually related to a lowering of tree vigor. Vigorous, healthy oaks are able to resist penetration by the fungus. Death or decreased vigor of oaks allows the fungus to penetrate, decay tissue, and form rhizomorphs. Oak stumps provide a food base for A. mellea. This food base is essential for the production and growth of rhizomorphs through the soil. Therefore, the presence or creation of dead oak roots/stumps increases the probability of infection of conifers in the immediate vicinity of the oak roots by rhizomorphs of the fungus. Oak stumps and roots heavily infected with A. mellea act as spread centers as long as they provide a suitable food base for the rhizomorphs.

Decreasing the amount of dead oak roots or stumps present at any one time will decrease the food base available for rhizomorph production and reduce the risk of subsequent spread from the food base via rhizomorphs to surrounding conifers. Cutting back young oaks and allowing them to sprout will decrease the food base available; the fungus will not be able to use the living roots as a food base for rhizomorph production. Small stumps (less than 4 inches) are not likely to cause much mortality unless they are very dense in a given area. Treating oaks so that they decline gradually rather than rapidly will also reduce the amount of food base available at any one time. If oaks are old and declining naturally, allowing them to continue declining slowly would decrease the risk of Armillaria buildup.

## MANAGEMENT OPTIONS

1. No change in present management. Dwarf mistletoe infection levels in Jeffrey pines are high throughout the campground. If nothing is done to control the disease, it will increase in intensity in trees already infected and spread to surrounding susceptible trees. Severely infected trees have a high probability of dying in 10 to 15 years. The true mistletoe present in only one area on white firs, will likely spread to firs in other parts of the campground.

Fomes annosus will persist in the infected stumps and roots until the wood is completely rotted. Host trees on the edge of active annosus centers will become infected and die, probably as a result of bark beetle attacks. Conifers planted in disease centers will die as their roots encounter old infected roots and stumps, and the fungus may be perpetuated in the area.

Trees under stress in the campground are more susceptible to bark beetle attack than healthy trees. The bark beetles attacking a tree will emit a pheromone which attracts other beetles into the area. Once the beetles are in the area, they may land on nearby trees. If enough beetles are present, they may be able to kill a relatively healthy tree. A single tree under stress can lead to the death of several nearby trees. In addition to dwarf mistletoe and root disease, pines are being stressed by oxidant air pollution damage. The trees are periodically stressed during drought, and increased mortality can be expected. Over-stocking in some parts of the campground is also contributing to tree stress.

2. Reduce impact of dwarf mistletoe. Several alternatives for reducing the impact of dwarf mistletoe in recreational sites are available. FPM funding is available for approved dwarf mistletoe control projects when K-V and P&M funds do not exist.

   a. Pruning of witches' brooms. The Green Valley Campground has trees which would benefit from pruning. The objective of broom pruning is to increase a tree's vigor, and therefore to prolong its life, by removing a source of nutrient and moisture drain. High-value trees can be pruned of brooms in the lower crown if, after removal of the brooms, the tree will still have a live crown ratio of 30% or more. When pruning, all broomed branches should be cut flush with the bole. It should be kept in mind that broom pruning of trees in active annosus centers may be fruitless because the trees could die from root rot and subsequent bark beetle attacks.

      Green pine slash caused by broom pruning should be treated so as to reduce the risk of pine engraver (Ips spp.) buildup. Slash created in the spring or early summer should be lopped and scattered, piled and burned while green, chipped, or removed from the site.

   b. Remove infected overstory trees to protect regeneration. If the objective is to save understory trees, the infected overstory trees should be removed to eliminate the source of inoculum. The understory should then be thinned and pruned to eliminate dwarf mistletoe infections. Some areas of the campground may be planted with susceptible conifers if removal of the infected overstory eliminates a source of infection.

   c. Thinning. Thinning of infected stands will aid in maintaining optimum growth of residuals and reduce stress. Following release, lightly infected residuals may vertically outgrow the dwarf mistletoe. Noninfected trees should be favored as leave trees. The removal of all trees with 6-class dwarf mistletoe ratings of 5 and

6 should be considered, because these trees have a high probability of dying in the next 10 to 15 years. Treat all freshly cut stumps with borax to prevent invasion by F. annosus.

3. Eradicate true mistletoe on white fir. White firs are a major component of the existing understory in the campground and are providing desired screening. Since true mistletoe is apparently present on white firs in only one area, an attempt to eradicate the parasite to prevent its spread to other parts of the campground could be made. For eradication to be successful, the entire area would need to be scouted carefully and all infected trees or parts of trees should then be cut. Periodic re-inspection of the area would be required to insure that all true mistletoe was eliminated.

4. Reduce impact of Fomes annosus. Once annosus root disease is established in a stand, no direct control is available. Control, therefore, involves prevention of new centers by decreasing the risk of stump infection, and silvicultural manipulation of infected stands to minimize the effects of the disease. The following alternatives are available:

   a. Prevent stump infections. Application of granular borax to freshly cut coniferous stumps is effective (90%) in preventing new infections. The chemical is toxic to the spores of F. annosus, but has no effect on existing infections. Borax application is required on all coniferous stumps cut in and near developed recreation sites (FSM R-5 Supp. 2305 and 2331.33). Application requires the prior submission of a Pesticide Use Proposal.

   b. Plant hardwoods. Revegetation of active annosus centers should be done only with resistant species. All conifers are susceptible to the disease. Leaving the centers barren or revegetating with resistant hardwoods will allow the fungus to eventually die out so that conifers can again be regenerated. Unfortunately, this may take up to 50 or more years.

      Favoring the oaks already present in the campground and planting oaks and other suitable hardwoods will provide shade as well as establish a barrier of non-susceptible roots that may limit the spread of infection centers.

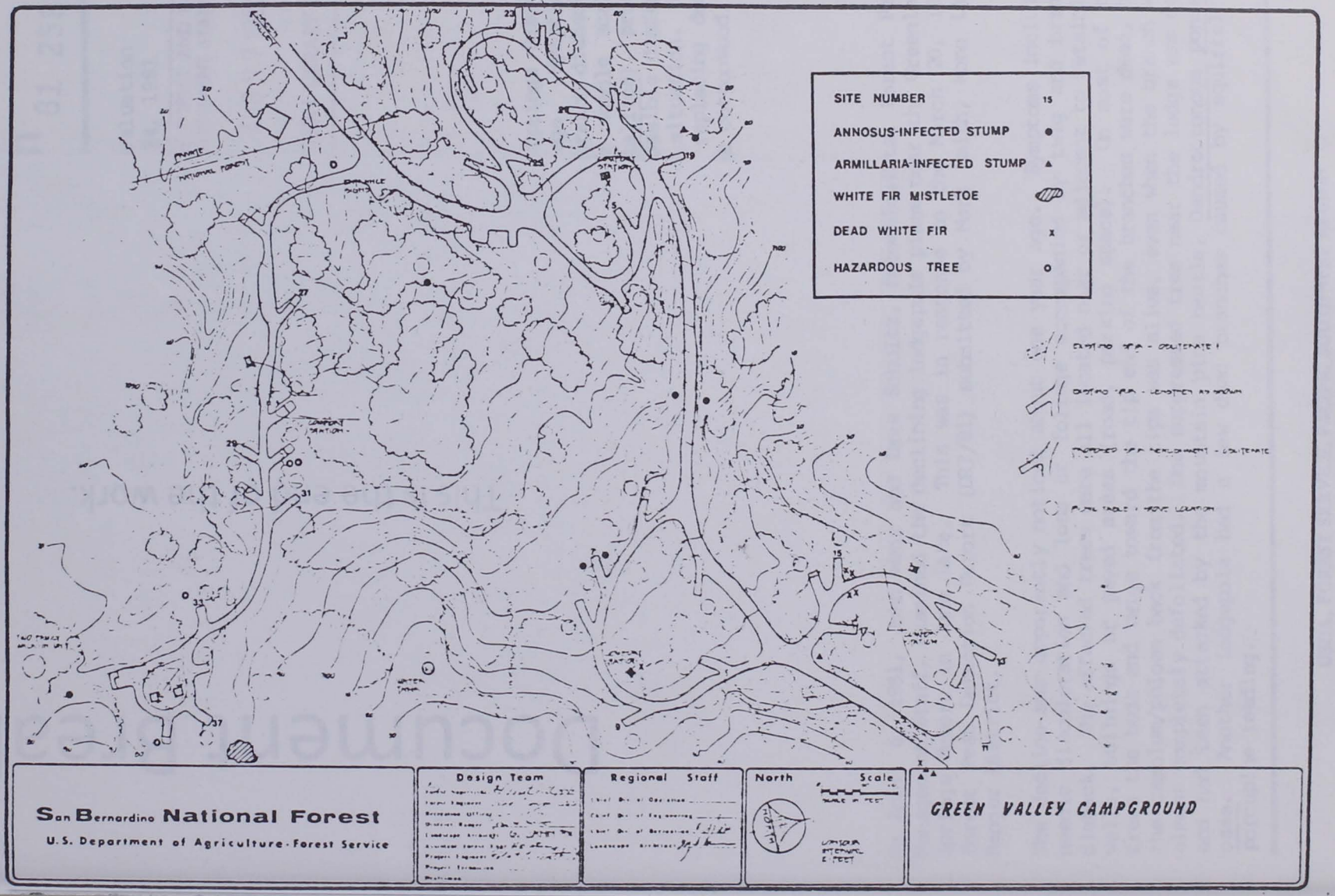
   c. Stump and root removal. Removal of as much infected material as possible may disrupt the underground network for fungal spread and establish a barrier to further spread. After the fine roots that remain in the soil have completely decomposed, the site will be suitable for conifer regeneration. Recently cut stumps within a disease center, both infected and uninfected, could be removed by excavation with a backhoe or by hand. Although removal of infected material from the ground may be effective in reducing the amount of time before conifers can again be planted on the site, its efficacy has not been tested under California conditions.

5. High-risk and hazardous tree removal. Old growth specimen trees are often desired in campgrounds because of their aesthetic appeal. In a few instances thinning may improve the vigor of nearby old growth trees, but in some old growth aggregates thinning may be inappropriate. Group kills in old growth aggregates can often be avoided, or postponed, by removing the tree(s) most likely to be attacked by bark beetles, before the trees come under attack. These high-risk trees can usually be recognized by outward signs of low vigor and slow growth. Hazardous trees, i.e., those with a good chance for failure, should be considered for removal in order to protect people and property.

6. Integrate treatments. Management alternatives 2 through 5 are not mutually exclusive; they can be used alone or in combination in various parts of the campground to produce the desired results. Considerations of the interactions among all insect and disease problems present will result in a successful integration of pest management strategies. For example, pines could be planted in open areas without annosus root disease, but their susceptibility to western dwarf mistletoe and oxidant air pollution would need to be considered. Incense-cedars, firs, sugar pines, or hardwoods may be more suitable. Only oaks or other resistant hardwood species should be considered for planting in identified annosus root disease centers.

   The objective of any pest management activity in the campground should be to promote the growth of healthy and vigorous, all-aged, mixed species, properly stocked stands. The integration of suppression and prevention methods into the long-term management of the area is necessary to completely fulfill this objective.

Forest Pest Management personnel are available to provide technical assistance both "on the ground" and in the planning process in order to reduce pest-related losses. If additional information regarding this evaluation, or information on applying for dwarf mistletoe suppression funds is needed, please contact the Forest Pest Management Staff.


SITE NUMBER 15
ANNOSUS-INFECTED STUMP
ARMILLARIA-INFECTED STUMP
WHITE FIR MISTLETOE
DEAD WHITE FIR
HAZARDOUS TREE
San Bernardino National Forest
U.S. Department of Agriculture - Forest Service
Design Team
Regional Staff
North
Scale
GREEN VALLEY CAMPGROUND